

*Rikaline* GPS-24 / 24A

# GPS Receiver Board

## User's Guide

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## 1. Introduction

### 1.1 Overview

The **Rikaline** GPS-24 / 24A is a GPS receiver board featuring Nemerix low power architecture. This complete enabled GPS receiver board provides high position and speed accuracy performances as well as high sensitivity and tracking capabilities in urban canyon conditions. The solution enables small form factor package. The GPS-24 / 24A delivers major advancements in GPS performances, accuracy, integration, computing power and flexibility. It is designed to simplify the embedded system integration process.

This positioning application meets strict needs such as car navigation, mapping, surveying, agriculture and so on. Only clear view of sky and certain power supply are necessary to the unit. GPS-24 / 24A communicates with other electronic utilities via compatible dual-channel through TTL and saves critical satellite data in built-in memory backup. With low power consumption, the GPS-24 / 24A tracks up to 16 satellites at a time, re-acquires satellite signals in 100 ms and updates position data every second.

### 1.2 Features

The GPS-24 / 24A provides a host of features that make it easy for integration and use.

1. Position accuracy in < 7m CEP (90%) without SA (horizontal)
2. Ultra low power: 30mW typical -- tracking at 3.3 Volts, full power
3. High sensitivity: to -152 dBm tracking, superior urban canyon performances
4. Small form factor and low cost solution
5. Ready-to-plug solution. Easily integrated into existing systems
6. On-board RAM for GPS navigation data
7. PPS output (User may have different interval setting from 1 second to 1 minute).
8. Differential capability utilizes real-time RTCM corrections producing < 1 meter position accuracy.
9. FLASH based program memory: New setting is stored permanently.

### 1.3 Application

1. Car Navigation
2. Mapping
3. Surveying
4. Agriculture
5. Palmtop, Laptop, PDA
6. Location Based Services enabled devices
7. Asset management/tracking
8. Handheld receivers
9. Radar detector with GPS function

### 1.4 Technology specifications

#### 1.4.1 Physical Dimension

1. Size: 25.9(W) x 25.9(D) x 2.7(H) (mm)  
1.02"(W) x 1.02"(D) x 0.11"(H)
2. Weight: 21 g

#### 1.4.2 Environmental Characteristics

- 1) Operating temperature: -40°C to +80°C (internal temperature)
- 2) Storage temperature: -55°C to +100°C

#### 1.4.3 Electrical Characteristics

- 1) Input voltage: +3.3 ±5% VDC.
- 2) HFL antenna connector: Active or patch (3.0V antenna is recommended).

#### 1.4.4 Performance

- 1) **Tracks** up to 16 satellites.
- 2) **Update rate:** 1 second.
- 3) **Sensitivity:**

Tracking: -152dBm  
Acquisition: -139dBm

**3) Acquisition time:**

Reacquisition	0.1 sec. (90%)
Hot start	12 sec. (90%)
Warm start	38 sec. (90%)
Cold start	60 sec. (90%)

**4) Position accuracy:**

Non DGPS (Differential GPS)

Position	<7m CEP (90%) with S/A off
Velocity	0.1 meters/second.
Time	1 microsecond synchronized GPS time

DGPS (Differential GPS)

Position	<1 m, typical
Velocity	0.05 meters/second, typical

**5) Dynamic Conditions:**

Altitude	10,000 meters(32,800 feet) max
Velocity	
Horizontal	300 Km/Hr
Vertical	36 Km/Hr
Acceleration	2 G, max
Jerk	4 meters/second <sup>3</sup> , max

**6) Time-1PPS Pulse (optional)**

Level	TTL
Pulse duration	100ms
Time reference	at the pulse positive edge
Measurements	Aligned to GPS second, +-1 microsecond

**7) 2.1.10 Recommended External Antenna Specification**

Gain	20dB (including cable loss)
Noise figure	1.5dB
Current	3 ~ 30mA
Operate Voltage	2.5 ~ 2.8V

**1.4.5 Interfaces**

- 1) Dual communication channel through TTL, with user selectable baud rate (4800, 9600-Default, 19200, 38400).
- 2) NMEA 0183 Version 3.0 ASCII output (GGA, GSV(3), GSA(3), RMC, VTG).
- 3) Real-time Differential Correction input (RTCM SC-104 message types 1, 2 and 9).

## **2. Operational characteristics**

### **2.1 Initialization**

As soon as the initial self-test is complete, the GPS-22 begins the process of satellite acquisition and tracking automatically. Under normal circumstances, it takes approximately 120 seconds to achieve a position fix, 42 seconds if ephemeris data is known. After a position fix has been calculated, information about valid position, velocity and time is transmitted over the output channel.

The GPS-22 utilizes initial data, such as last stored position, date, time and satellite orbital data, to achieve maximum acquisition performance. If significant inaccuracy exists in the initial data, or the orbital data is obsolete, it may take more time to achieve a navigation solution. The FirstGPS™ architecture provides superior performance. However, acquisition performance can be improved as the host system initializes the GPS-22 in the following situation:

1. Moving further than 1,500 kilometers.
2. Failure of Data storage due to the inactive memory power back up.

### **2.2 Navigation**

After the acquisition process is complete, the GPS-22 sends valid navigation information over output channels. These data include:

- 1) Latitude/longitude/altitude
- 2) Velocity
- 3) Date/time
- 4) Error estimates
- 5) Satellite and receiver status

The GPS-22 sets the default of auto-searching for real-time differential corrections in RTCM SC-104 standard format, with the message types 1, 2, or 9. It accomplishes the satellite data to generate a differential (DGPS) solution. The host system, at its option, may also command the GPS-22 to output a position whenever a differential solution is available.

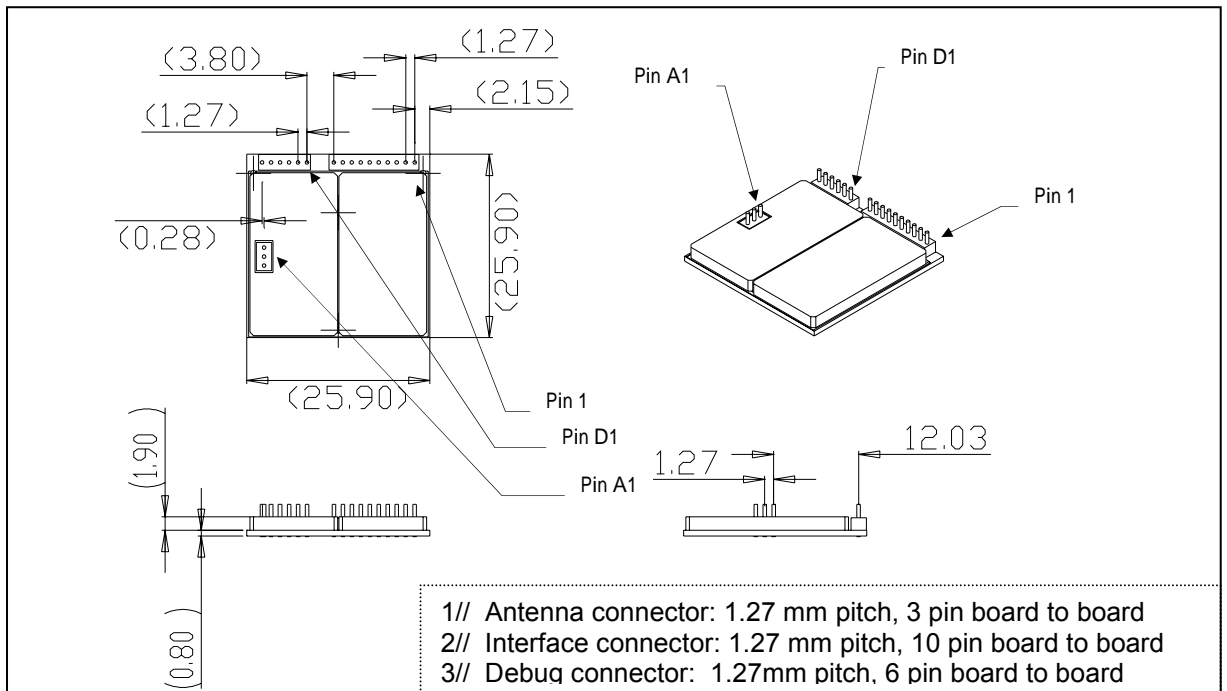
### 3. Hardware interface

#### 3.1 Physical Characters

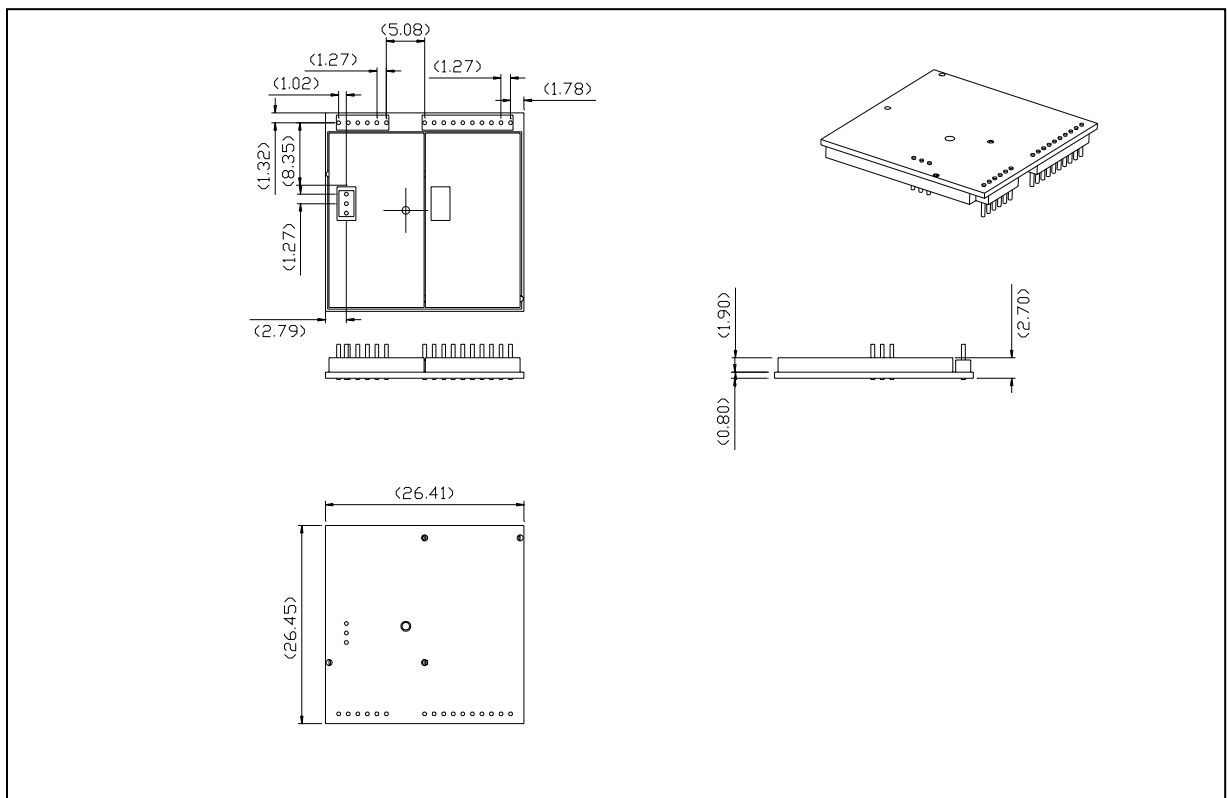
1. Size: 25.9(W) x 25.9(D) x 2.7(H) (mm)  
1.02"(W) x 1.02"(D) x 0.11"(H)
2. Weight: 25 g

##### 3.1.1 Details Drawing

###### 3.1.1.1GPS-24 (to be equipped with active antenna only)



###### 3.1.1.1GPS-24A (to be equipped with passive antenna or/and active antenna)



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## 3.2 Pin Definition

PIN	NAME	TYPE	DESCRIPTION	Remarks
1	GPIO(4)	I \ O	GPS Status	
2	NC (MODE)	NU	Reserved, keep float	
3	NMEA Tx	I \ O	NMEA Serial Data Output	
4	NMEA Rx	I \ O	NMEA Serial Data Input	
5	NC (WAKE UP)	NU	Reserved, keep float	
6	Reset	I	Low Active, keep float if not use *1	Will not effect hot, or cold start
7	VBAT	I	Backup Battery Input (1.2~2V)	
8	GND	PWR	Ground	
9	VCC	PWR	+3.0~3.6V DC Power Input	
10	GPIO(0)	I \ O	SW dependent functions	
A1	RF GND	ANT	Antenna ground	
A2	RF IN	ANT	Antenna +	
A3	RF GND	ANT	Antenna ground	
D1	DSUMUX	I	Serial / DSU select	
D2	DSUEN	I	DSU enable	
D3	DSUBRE	I	DSU break enable	
D4	DSUTX	O	DSU transmitter	
D5	DSURX	I	DSU receiver	
D6	DSUACT	O	DSU active	

## 3.3 Operating Modes

### 3.3.1 GPIO(1) & (4)

It design as spare I/O. You may leave it disconnect of desire.

### 3.3.2 Reset:

It always requires reset when power-up. Max voltage is 2.0VDC  
And will not effect cold start or hot start.

### 3.3.3 Debug Pins

All pins from D1 to D6 is for development purposes, not for end users except downloading new software.

### 3.3.4 Developing Kit

Available at part no. GPS-24-SDK

## 3.4 Other Electrical Specification

Table 3-1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Power Supply Voltage	VDD	-0.3	3.6	V
Input Pin Voltage	VIN	-0.3	3.3	V
Output Pin Voltage	VOUT	-0.3	3	V
Reset Pin Voltage	Vreset	-0.3	2.0	V
Storage Temperature	TSTG	-40	100	°C
Back-up Voltage	BAT		2.2	V

Table 3-2 Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Power Supply Voltage	VCC	3	3.3	3.6	V
Input Pin Voltage	VIN	2.7	3	3.3	V
Operating Temperature	TOPR	-40		85	°C
Operating Current ZX4120	ICC		27		mA

Table 3-3 Backup Battery Conditions

Parameter	Symbol	Min	Typ	Max	Units
RTC(Battery) Power	BAT	1.2	1.8	2	V
Supply Current			10		$\mu$ A

Table 3-4 DC Characteristics

Parameter	Symbol	Min	Max	Units
Input High Level	Vih	2.5	3.5	V
Input Low Level	Vil	0	0.8	V
Output High Level	Voh	2.4	3.4	V
Output Low Level	Vol	0	0.4	V
Input Leakage Current	Li	2	2	$\mu$ A

## 4. Software Interface

The GPS-24 / 24A interface protocol is based on the National Marine Electronics Association's NMEA 0183 ASCII interface specification, which is defined in NMEA 0183, Version 3.0 and the Radio Technical Commission for Maritime Services (RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.1, RTCM Special Committee No.104).

### 4.1 NMEA Transmitted Messages

The GPS-24 / 24A outputs data in NMEA-0183 format as defined by the National Marine Electronics Association (NMEA), Standard.

The default communication parameters for NMEA output are 9600 baud, 8 data bits, stop bit, and no parity.

Table 4-1 NMEA-0183 Output Messages

NMEA Record	Description
<b>GPGGA</b>	Global positioning system fixed data
<b>GPGLL</b>	Geographic position- latitude/longitude
<b>GPGSA</b>	GNSS DOP and active satellites
<b>GPGSV</b>	GNSS satellites in view
<b>GPRMC</b>	Recommended minimum specific GNSS data
<b>GPVTG</b>	Course over ground and ground speed
<b>GPZDA</b>	Date & Time

Detailed NMEA information is in Appendix A

### 4.2 RTCM Received Data

The default communication parameters for DGPS Input are 9600 baud, 8 data bits, stop bit, and no parity. Position accuracy of less than 5 meters can be achieved with the GPS-24 / 24A by using Differential GPS (DGPS) real-time pseudo-range correction data in RTCM SC-104 format, with message types 1, 5, or 9. As using DGPS receiver with different communication parameters, GPS-24 / 24A may decode the data correctly to generate accurate messages and save them in battery-back SRAM for later computing.

### 4.3 Earth Datums

The GPS-24 / 24A is built in earth datum with WGS84.



## 5. Ordering Information

### 5.1 Products Options

#### 5.1.1 GPS Receiver Module

GPS-24 Standard with TTL level.

GPS-24-A Standard with TTL level, and available to attach patch antenna on top of the board.

### 5.2 Accessories

A-10302-M Active Antenna, 2M, MMCX connector.

A-10305-M Active Antenna, 5M, MMCX connector.

## 6. Warranty

The GPS-24 / 24A series products are warranted to be free from defects in material and functions for one year from the date of purchase. Any failure of this product within this period under normal conditions will be replaced at no charge to the customers.

## Appendix A Software Interface

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### A.1 NMEA Transmitted Messages

The GPS-24 / 24A outputs data in NMEA-0183 format as defined by the National Marine Electronics Association (NMEA), Standard.

The default communication parameters for NMEA output are 9600 baud, 8 data bits, stop bit, and no parity.

Table A-1 NMEA-0183 Output Messages

NMEA Record	Description
<b>GP GGA</b>	Global positioning system fixed data
<b>GP LLL</b>	Geographic position- latitude/longitude
<b>GP GSA</b>	GNSS DOP and active satellites
<b>GP GSV</b>	GNSS satellites in view
<b>GP RMC</b>	Recommended minimum specific GNSS data
<b>GP VTG</b>	Course over ground and ground speed
<b>GP ZDA</b>	Date & Time

#### A.1.1 Global Positioning System Fix Data (GGA)

**\$GP GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000\*18**

Table A-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GP GGA		GGA protocol header
UTC Time	161229.487		Hhmmss.sss
Latitude	3723.2475		Ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 5-3
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	Meters	
Units	M	Meters	
Geoid Separation		Meters	
Units	M	Meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
<CR> <LF>			End of message termination

Table A-3 Position Fix Indicator

Value	Description
0	0 Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

#### A.1.2 Geographic Position with Latitude/Longitude (GLL)

Table 4-4 contains the values for the following example:

**\$GPGLL,3723.2475,N,12158.3416,W,161229.487,A\*2C**

Table A-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GPGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
<CR> <LF>			End of message termination

#### 4.1.3 GNSS DOP and Active Satellites (GSA)

Table A-5 contains the values for the following example:

**\$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5\*33**

Table A-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header
Mode 1	A		See Table 5-6
Mode 2	3		See Table 5-7
Satellite Used (1)	07		Sv on Channel 1
Satellite Used (1)	02		Sv on Channel 2
.....			....
Satellite Used			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
<CR> <LF>			End of message termination

(1) Satellite used in solution.

Table A-6 Mode 1

Value	Description
M	Manual—forced to operate in 2D or 3D mode
A	2D Automatic—allowed to automatically switch 2D/3D

Table A-7 Mode 2

Value	Description
1	Fix Not Available
2	2D
3	3D

#### A.1.4 GNSS Satellites in View (GSV)

Table A-8 contains the values for the following example:

**\$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42\*71**  
**\$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42\*41**

Table A-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Number of Messages	2		Range 1 to 3

Message Number	1		Range 1 to 3
Satellites in View	07		Range 1 to 12
Satellite ID	07		Channel 1 (Range 1 to 32)
Elevation	79	degrees	Channel 1 (Maximum 90)
Azimuth	048	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
....	....		
Satellite ID	27		Channel 4 (Range 1 to 32)
Elevation	27	degrees	Channel 4 (Maximum 90)
Azimuth	138	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR> <LF>			End of message termination

**NOTE:** Items <4>, <5>, <6> and <7> repeat for each satellite in view to a maximum of four (4) satellites per sentence. Additional satellites in view information must be sent in subsequent sentences. These fields will be null if unused.

### A.1.5 Recommended Minimum Specific GNSS Data (RMC)

Table A-9 contains the values for the following example:

**\$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598, ,\*10**

Table A-9 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	Knots	
Course Over Ground	309.62	Degrees	True
Date	120598		Ddmmyy
Magnetic Variation		Degrees	E=east or W=west
Checksum	*10		
<CR> <LF>			End of message termination

### A.1.6 Course Over Ground and Ground Speed (VTG)

Table A-10 contains the values for the following example:

**\$GPVTG,309.62,T, ,M,0.13,N,0.2,K\*6E**

Table A-10 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course	309.62	Degrees	Measured heading
Reference	T		True
Course		Degrees	Measured heading
Reference	M		Magnetic (1)
Speed	0.13	Knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	Km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Checksum	*6E		
<CR> <LF>			End of message termination

(1) All "course over ground" data are geodetic WGS84 directions.

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**A.1.7 Time & Date (ZDA)**

Table A-11 contains the values for the following example:

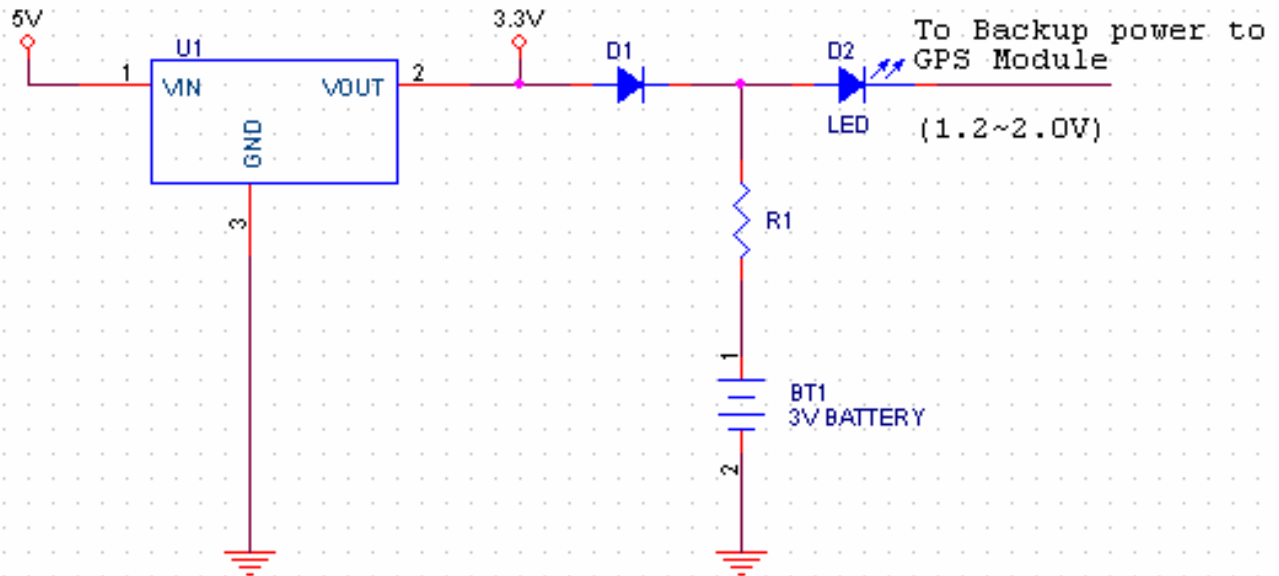
**\$GPVTG,114523.62,12,04,2001,10,34\*6E**

Table A-11 ZDA Data Format

<b>Name</b>	<b>Example</b>	<b>Units</b>	<b>Description</b>
Message ID	\$GPZDA		ZDA protocol header
Hour, Min, Sec, Sub Sec	114523.62		Hhmmss.ss
Day	12		Day in UTC, 01to 12
Month	04		Month in UTC, 01 to 12
Year	2001		Year in UTC
Local Zone Hours	10		Local zone hours, +/- 13 hours
Local Zone Minutes	34		Local zone minutes, 0 to +59
Checksum	*6E		
<CR> <LF>			End of message termination

## Appendix B Reference Design

Backup Battery reference design :  
(rechargeable Lithium battery)



U1 constant voltage element  
D1 select a shotkey diode of small inverse current  
R1 selected depend on charge voltage of battery

for example :

U1 : RT9167-33CB (RICHTEK)  
D1 : BAT54 (FAIRCHILD)  
R1 : 100 Ohm  
D2 : LED  
Battery : ML414S (Panasonic)

## Appendix C Developer's Setting

For all \$PNMRX messages, it is possible to configure an alternative string to replace the NMRX part, the node always responds to the \$PNMRX strings and can be configured to generate and respond to the alternative string.

### C.1 \$PNMRX100, Set serial port mode

This message is sent to control the serial communications port parameters. The \$PNMRX100 message format is shown below.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX100	6	6	PNMRX100 protocol header.
Protocol	Char	1	1	0 NMEA mode 1 Nemerix Binary Mode (under dev)
Baud	Int	4	6	1200 / 2400 / 4800 / 9600 / 19200 / 38400 / 57600.
Parity	Char	1	1	0. None. 1. Odd. 2. Even.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

#### Examples:

\$PNMRX100,0,4800,0\*xx: sets the UART baud rate to 4800 bps and no parity.

### C.2 \$PNMRX101, Navigation Initialization

This message is sent to initialize navigation parameters to speed up initial acquisition time. The \$PNMRX101 message format is shown below.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX101	6	8	PNMRX101 protocol header.
ECEF_X	Int	(-7	(-7	Signed ECEF x co-ordinate in meters
ECEF_Y	Int	(-7	(-7	Signed ECEF y co-ordinate in meters
ECEF_Z	Int	(-7	(-7	Signed ECEF z co-ordinate in meters
Clock offset	Int	(0) 1	6	Clock offset of GPS receiver, in [Hz x 100] wrt L1. This changes the clock bias stored in the settings not the actual clock bias used by the system. A cold start is necessary, in order to use this value.
Time of week	Int	1	6	Offset from start of week in seconds
Week number	Int	1	4	GPS week number
Channel count	Int	1	2	Maximum number of TM to be used. Min 12, max 16.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

Note: 1// If used, all three X,Y, and Z components of the ECEF position must be provided, otherwise the message is declared invalid as a whole

2// Modifying the ECEF coordinates triggers a software system reset after successful execution of the message

#### Examples:

\$PNMRX101,,,,,,,,,8,\*xx:

Executes a factory reset

\$PNMRX101,-742507,-5462738, 3196706,\*xx: Sets the receiver position to ECEF (,) and executes a software reset

\$PNMRX101, 4,\*xx:

Sets the fix procedure mode the cold start. This will be valid after each reset, until this value is changed.

### C.3 \$PNMRX103, NMEA rate control

This message is being sent to enable or to disable the output of an NMEA message and to determine its output rate. The sequence of the output sequence is determined by the \$PNMRX107 message. The \$PNMRX103 message format is shown below. The rate of each message can individually be set. If '0' is used, the output of the message is skipped (according to the message sequence). The message length is limited to 80 characters, in the event that the message length would exceed 80 characters it is divided into 2 messages. This message is supported also in a variable length format, where only the necessary fields are used.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX103	8	8	PNMRX103 protocol header.
Mask ID	Int	3	3	Mask identifier: possibilities are GGA / GLL / GSA / GSV RMC / VTG / ZDA ALL (applies to all messages)
Mask value	Int	1	1	Output rate in seconds (0=paused)
Mask ID	Int	2	2	Mask identifier.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

#### Examples:

\$PNMRX103, GSV, 2,GGA, 1,ZDA, 0\*xx: **GSV is output every 2s,GGA every 1s and ZDA is skipped.**

\$PNMRX103, GSV, 2, GGA, 1, ZDA, 0,\*xx: **same as above, but using a fixed length message**

\$PNMRX103, ALL, 2\*xx: **all messages are output every 2s.**

\$PNMRX103, ALL, 0\*xx: **skips all messages.**

### C.4 \$PNMRX104, LLA navigation initialization

This message enables the receiver to be initialized using LLA data to speed up satellite acquisition. The first 4 values defining the position (if used) must be all present in the message. Otherwise the whole message is considered invalid.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX104	8	8	PNMRX104 protocol header. (Under dev.)
Latitude	Float	1,2.1	3,2.4	Degrees * 100 + minutes. (Under dev.)
N/S Indicator	Char	1	1	N=north or S=south. (Under dev.)
Latitude	Float	1,2.1	3,2.4	Degrees * 100 + minutes. (Under dev.)
E/W Indicator	Char	1	1	E=east or W=west. (Under dev.)
Altitude	Int	(-) 1	(-) 6	Altitude above MSL, in meters.
Clock offset	Int	(0) 1	6	Clock offset of GPS receiver. These changes the clock bias stored in the settings, not the actual clock bias used by the system. A cold start is necessary, in order to use this value.
Time of week	Int	1	6	Offset from start of week in seconds. (Under dev.)
Week number	Int	1	4	GPS week number.
Channel count	Int	1	2	Maximum number of TM to be used. Min12, max 16.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

Note: 1// If used, all five components (Lat, N/S, Long E/W, alt) of the LLA position must be provided. Otherwise, the message is declared invalid as a whole

2// Modifying the LLA coordinates triggers a software system reset after successful execution of the message.



## C4.5 \$PNMRX106, Datum

This message defines the conversion model used for mapping the ECEF coordinates into the LLA ones. The default transformation uses WGS84 approximation. The transformation method can be changed into one using a reference Ellipsoid combined with a local datum, to obtain a specific estimation of the local earth geometry. Once the datum has been changed it will be applied to all LLA data, including the LLA navigation initialization Data. This message enables the receiver to be configured to use map datum from an internal table, or datum supplied as part of the message.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX106	6	8	PNMRX106 protocol header.
Correction Mode	Unsigned	1	1	If 1 apply EGM96 geoids correction (warning: should be applied only when Map Datum is equal to 216). If 0 there is no EGM96 geoids correction.
Map Datum	Int	(0) 1	3	Reference number of the appropriate map datum to apply. 0-218 Map datum from internal table 500 User defined Datum
Dx	Int	(0) (-)1	(-)5	X offset in meters (-9999 to 9999)
Dy	Int	(0) (-)1	(-)5	Y offset in meters (-9999 to 9999)
Dz	Int	(0) (-)1	(-)5	Z offset in meters (-9999 to 9999)
Iflat	Int	(0) 1	8	Inverse flatness of reference geode. The value to be used is (IFlat – 290) * 1000000). The value must be in the range [6000000, 12000000]
Majora	Int	(0) 1	8	Semi major axis of reference geode. The values to be used is (MajorA – 6370000) * 1000). The value must be in the range [6000000, 9000000]
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

### Examples:

\$PNMRX106, 0,500, -2000,-2000,-2000, 8257224, 8137000\*00\*xx: **User defined Datum**

\$PNMRX106, 1, 216,\*xx:

**WGS 84 Datum**

## C.6 \$PNMRX107, Messages rate control

This message is sent to set the automatic update rate, and to configure which messages will be automatically output, it is also sent from the node to report which messages are currently configured for automatic transmission. The \$PNMRX107 message format is shown below. This message can be used to enable and disable multiple messages by including up to 4 message codes and associated fields in each \$PNMRX107 message.

The message length is limited to 80 characters, in the event that the message length would exceed 80 characters it is divided into 2 messages. This message is supported also in a variable length format, where only the necessary fields are used.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX107	8	8	PNMRX107 protocol header.
Message code	Char	3	3	Determines which message is being configured. 300 PNMRX300 Almanac Data 301 PNMRX301 Ephemeris Data 302 PNMRX302 Ionospheric corrections 303 PNMRX303 UTC Time 304 PNMRX304 GPS constellation health ALL Applies to all messages

Mode	Int	1	1	0 Disable message 1 Send message now 2 Send message on change 3 Send message now and on change
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**Examples:**

\$PNMRX107, 300, 1\*xx: **Output the almanac stored in NVRAM**

\$PNMRX107, 301, 2\*xx: **Output Ephemeris will be output on change**

\$PNMRX107, ALL, 2\*xx: **Output all ZX4120 output messages (300,301,302,303,304)**

**C.7 \$PNMRX108, NMEA message sequence**

This message is used to set the sequence used to output the NMEA messages. All messages in the list are set to be output with a default output rate. The messages that are not included are disabled. Once the sequence is defined, individual settings for the messages can be changed by means of the \$PNMRX103 message. This message is supported also in a variable length format, where only the necessary fields are used.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX108	6	8	PNMRX108 protocol header.
Mask ID	Int	3	3	Mask identifier: possibilities are GGA / GLL / GSA / GSV RMC / VTG / ZDA
Mask ID	Int	3	3	Mask Identifier.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**Examples:**

\$PNMRX108, GGA, GLL, and GSA\*xx: **Enables the GGA, GLL and GSA in this sequence, output Every second. All other messages are disabled**

**C.7 \$PNMRX110, Fix Settings**

This message is used to set various settings and masks which control how the software will behave in relationship to the satellites in view, for example a mask can be set for the minimum satellite elevation, minimum SNR etc. The message consists of a varying number of fields depending on the number of masks to be set. Each mask setting consists if a mask identifier and new value pair. The \$PNMRX110 message format is shown below.

**PNMRX110 field list**

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX110	6	8	PNMRX110 protocol header.
Mask ID	Int	2	2	Mask identifier, see below.
Value	Variant	1	8	New value for mask, dependent on the preceding field, see below.
Mask ID	Int	2	2	Mask identifier.
Value	Variant	1	8	New value for mask, dependent on the preceding field.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**PNMRX110 Mask Field interpretation**

Mask Id	mask	format	width	units
0	Local Time Zone	Int: unsigned	2:2	Hours : Minutes
1	Maximum PDOP <sup>1</sup>	Unsigned	4	x10, [0-100]
2	Maximum HDOP	Unsigned	4	x10, [0-100]

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3	Maximum VDOP <sup>1</sup>	Unsigned	4	x10, [0-100]
4	Minimum SNR	Unsigned	2	dB/Hz, [20-45]
5	Minimum Elevation	Unsigned	2	Degrees, [0-90]
6	Noise Floor	Unsigned	4	-, [400-1000]
7	Navigation Mode 1 <sup>1</sup>	Unsigned	1	1 = Auto (hold alt) 2 = 2D Mode 4 = 3D Mode (calc alt)
8	2D Mode Altitude <sup>1</sup>	Unsigned	6	Meters above MSL
9	Navigation Mode 2 <sup>1</sup>	Boolean	1	0 = Auto 1 = Static
10	Maximum Altitude	Unsigned	6	Meters.

**Examples:**

\$PNMRX110, 0,-2:0\*xx: **Set the local time to -2 hours 0 minutes.**

\$PNMRX110, 4, 35\*xx: **Set the minimum SNR to 35**

**C.8 \$PNMRX111, Software reset**

This message is used to reset the systems. If the message is sent without parameters the receiver reboots according to the fix procedure (hot, warm or cold) configured with the PNMRX101 or PNMRX104 messages. A second parameter can optionally be used to specify which actions are executed after the reset. If the last bit field is set to '1', then the actions are repeated permanently at each reset, until this bit is cleared.

Field	Format	Min chars	Max chars	Notes																		
Message ID	\$PNMRX111	6	8	PNMRX111 protocol header.																		
Invalidate parameter	Integer OR String	1	7	<p>If integer, the bit field have the following meaning (the action described is executed if the bit is 1):</p> <table border="0"> <tr> <td>Field</td> <td>Action</td> </tr> <tr> <td>0</td> <td>Reload settings from Flash</td> </tr> <tr> <td>1</td> <td>Clear almanac data and don't load if from flash</td> </tr> <tr> <td>2</td> <td>Clear Ephemeris data</td> </tr> <tr> <td>3</td> <td>Clear ionosphere and troposphere corrections</td> </tr> <tr> <td>4</td> <td>Invalidate stored position</td> </tr> <tr> <td>5</td> <td>Invalidate stored time</td> </tr> <tr> <td>6</td> <td>Copy oscillator offset from Settings</td> </tr> <tr> <td>7</td> <td>Sticky bit -if '1' the action are repeated at each reset</td> </tr> </table> <p>If String, the following values are allowed:            FACTORY See Section 2.1 for definition.            COLD See Section 2.1 for definition.            WARM See Section 2.1 for definition.            HOT See Section 2.1 for definition.</p>	Field	Action	0	Reload settings from Flash	1	Clear almanac data and don't load if from flash	2	Clear Ephemeris data	3	Clear ionosphere and troposphere corrections	4	Invalidate stored position	5	Invalidate stored time	6	Copy oscillator offset from Settings	7	Sticky bit -if '1' the action are repeated at each reset
Field	Action																					
0	Reload settings from Flash																					
1	Clear almanac data and don't load if from flash																					
2	Clear Ephemeris data																					
3	Clear ionosphere and troposphere corrections																					
4	Invalidate stored position																					
5	Invalidate stored time																					
6	Copy oscillator offset from Settings																					
7	Sticky bit -if '1' the action are repeated at each reset																					
Checksum	*xx	(0) 3	3	2 digits.																		
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.																		

**Examples:**

\$PNMRX111\*xx: **Resets the system**

**C.8 \$PNMRX112, Power Mode Control**

This message is used to configure the operating modes of the receiver. Low power modes can be activated and configured. Low power mode starts to work only after the receiver has a complete and up to date almanac and it can produce the fix.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX112	6	8	PNMRX112 protocol header.
Operating Mode	Into	1	1	0 = Fully Active 1 = LDCM1
OFF period	Into	1	2	RF off time in seconds [5:10]
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**Examples:**

\$PNMRX112, 1, 5\*xx: **enable low power mode (with 5 seconds off time between 2 fixes)**

**C.9 \$PNMRX113, GPS Core Activity Control**

This message is used to disable GPS Core activities (data extraction and fix generation) on the node. The goal of this message is to disable these two functions when they need to be overwritten by external values for test purpose. A reset message must be set after the PNMRX113 in order to resume operation. For instance if a different almanac needs to be downloaded to the receiver then, data extraction must be disabled, then the new almanac can be downloaded. A reset command will then be used to restore operation with hen new almanac.

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX113	6	8	PNMRX113 protocol header.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**Examples:**

\$PNMRX113\*xx: **Stops GPS Core activities.**

**C.10 \$PNMRX300, Almanac Data Transfer**

This message format is used to transfer the almanac data between nodes; it uses a packed hexadecimal format to transfer almanac data for each of the available SV's. Since the Almanac data is large and can take time to transfer over a slow serial interface, the data is divided into individual messages for each of the SV's. These messages are transmitted sequentially and can be interleaved with other messages to prevent the Almanac data blocking higher priority messages such as scheduled PVT information. The data for these messages is expressed as signed or unsigned fixed point values which have been scaled from the floating point values used in the position solution. The appropriate scaling factors are included in the table. There is 1 message for each satellite for which data is available. When transmitted these messages are generated in ascending order of SV Id, when being sent to the node these can be sent in any order, each message is individually interpreted and processed.

Field	Format	width	scale	Notes
Message ID	\$PNMRX300	8		PNMRX300 protocol header.
SV Id	Int	2		Decimal Satellite vehicle Id from 1 to 32.
e	Hex	4	$2^{-21}$	16 bit signed int, scale.
Health	Hex	2		Bitmap of satellite health.
T <sub>oa</sub>	Hex	2		Week Number
$\delta_i$	Hex	4	$2^{-19}$	16 bit signed int.
Omega dot	Hex	4	$2^{-38}$	16 bit signed int.
Root_A	Hex	6	$2^{-11}$	24 bit unsigned int.
Omegazero	Hex	6	$2^{-23}$	24 bit signed int.
Perigee	Hex	6	$2^{-23}$	24 bit signed int.
Mean	Hex	6	$2^{-23}$	24 bit signed int.
Mean anomaly	Hex	6	$2^{-23}$	24 bit signed int.
af0	Hex	6	$2^{-20}$	11 bit signed int.
af1	Hex	6	$2^{-68}$	11 bit signed int.
Checksum	*xx	(0) 3		2 digits.

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Message terminator	<CR> <LF>	2		ASCII 13, ASCII 10.
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### C.11 \$PNMRX301, Ephemeris Data Transfer

This message format is used to transfer the ephemeris data between nodes; it uses a packed hexadecimal format to transfer ephemeris data for each of the available SV's. Since the Ephemeris data is large and can take time to transfer over a slow serial interface, the data is divided into individual messages for each of the SV's. These messages are transmitted sequentially and can be interleaved with other messages to prevent the Ephemeris data blocking higher priority messages such as scheduled PVT information. The data for these messages is expressed as signed or unsigned fixed point values which have been scaled from the floating point values used in the position solution. The appropriate scaling factors are included in the table. The ephemeris data for each satellite is divided into 3 separate messages with sequence numbers to identify them, the contents of these frames reflects the contents of the appropriate subframes 1,2,3 transmitted from the SV's. When transmitted these messages are generated in ascending order of SV Id and sequence number, when being sent to the node these can be sent in any order, provided that the 3 messages for any individual satellite are grouped together, each message is individually interpreted and after a group of 3 valid messages for an SV the ephemeris for that SV is updated independently. The 3 message formats are illustrated in the following tables

#### PNMRX301 message 1 field list

Field	Format	width	scale	Units	Notes
Message ID	\$PNMRX301	8			PNMRX301 protocol header.
Satellite vehicle Id	Int	2			Decimal satellite vehicle Id from 1 to 32.
Subframe Id	Int	1			Subframe number 1.
Week number	Hex	3		Weeks	10 bit week number.
Health	Hex	2			6 bits.
URA	Hex	1			User range accuracy.
Time Group Delay	Hex	2	$2^{-31}$	Seconds	8 bits.
IODC	Hex	3			10 bit integer.
Toc	Hex	4	$2^{-4}$		16 bits.
Af2	Hex	2	$2^{-31}$	sec/sec <sup>2</sup>	8 bit signed integer.
Af1	Hex	4	$2^{-43}$	sec/sec	16 bit signed integer.
Af0	Hex	6	$2^{-31}$	Seconds	22 bit signed integer.
Checksum	*xx	(0) 3			2 digits.
Message terminator	<CR> <LF>	2			ASCII 13, ASCII 10.

#### PNMRX301 message 2 field list

Field	Format	width	scale	units	Notes
Message ID	\$PNMRX301	8			PNMRX301 protocol header.
Satellite Vehicle Id	Int	2			Decimal satellite vehicle id from 1 to 32.
Subframe Id	Int	1			Subframe number 2.
Iode	Hex	2			8 bits, lower 8 bits of matching iodc.
Crs	Hex	4	$2^{-5}$	Meters	16 bit signed integer.
Motion difference ( n)	Hex	4	$2^{-43}$	Semi-circles/sec	16 bit signed integer.
Mean anomaly	Hex	8	$2^{-31}$	Semi-circles	32 bit signed integer.
Cuc	Hex	4	$2^{-29}$	Radians	16 bit signed integer.
E	Hex	8	$2^{-33}$		32 bit signed integer.
Cuc	Hex	4	$2^{-29}$	Radians	16 bit signed integer.
Root A	Hex	8	$2^{-19}$	Meters <sup>1/4</sup>	32 bit signed integer.
Toe	Hex	4	$2^4$	seconds	16 bit unsigned integer.
Checksum	*xx	(0) 3			2 digits.
Message terminator	<CR> <LF>	2			ASCII 13, ASCII 10.

**PNMRX301 message 3 field list**

Field	Format	width	scale	units	Notes
Message ID	\$PNMRX301	8			PNMRX301 protocol header.
Satellite Vehicle Id	Int	2			Decimal satellite vehicle id from 1 to 32.
Subframe Id	Int	1			Subframe number 3.
Cic	Hex	4	$2^{-29}$	Radians	16 bit signed integer.
Omega zero	Hex	8	$2^{-31}$	Semi- circles	32 bit signed integer.
Cis	Hex	4	$2^{-29}$	radians	16 bit signed integer.
I Zero	Hex	4	$2^{-31}$	Semi- circles	32 bit signed integer.
Crc	Hex	4	$2^{-5}$	Meters	16 bit signed integer.
Perigree	Hex	8	$2^{-31}$	Semi- circles	32 bit signed integer.
Omega dot	Hex	6	$2^{-43}$	Semi- circles/sec	24 bit signed integer.
Iode	Hex	2			Lower 8 bits of matching iodec.
I dot	Hex	4	$2^{-43}$	Semi- circles/sec	14 bit signed integer.
Checksum	*xx	(0) 3			2 digits.
Message terminator	<CR> <LF>	2			ASCII 13, ASCII 10.

**C.12 \$PNMRX302, Ionospheric correction**

Field	Format	width	scale	units	Notes
Message ID	\$PNMRX302	8			PNMRX301 protocol header.
Satellite Vehicle Id	Int	2			Decimal satellite vehicle id from 1 to 32.
$\alpha 0$	Hex	2	$2^{-30}$		
$\alpha 1$	Hex	2	$2^{-27}$		
$\alpha 2$	Hex	2	$2^{-24}$		
$\alpha 3$	Hex	2	$2^{-24}$		
$\beta 0$	Hex	2	$2^{11}$		
$\beta 1$	Hex	2	$2^{14}$		
$\beta 2$	Hex	2	$2^{16}$		
$\beta 3$	Hex	2	$2^{16}$		
Checksum	*xx	(0) 3			2 digits.
Message terminator	<CR> <LF>	2			ASCII 13, ASCII 10.

**C.13 \$PNMRX303,UTC time**

Field	Format	width	scale	units	Notes
Message ID	\$PNMRX303	8			PNMRX301 protocol header.
Satellite Vehicle Id	Int	8			Decimal satellite vehicle id from 1 to 32.
Data – A0	Hex	2			Constant term of the polynomial
Data – A1	Hex	2			First-order term of the polynomial.
Delta t LS	Hex	2			Delta time due to leap seconds.
Tot	Hex	2			Reference time for UTC.
WNt	Hex	2			UTC reference week number
WNIsf	Hex	2			Week number at which the leap second becomes effective.
DN	Hex	2			Day number B2.
Delta t LSF	Hex	2			Delta time due to leap seconds if leap second is in the past.
NumBlocks	Hex	2			Number of 20 year blocks
Time Offset	Hex	2			Time offset for current time zone
Checksum	*xx	(0) 3			2 digits.
Message terminator	<CR> <LF>	2			ASCII 13, ASCII 10.

## C.14 \$PNMRX304, GPS Constellation Health

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX304	8	8	PNMRX110 protocol header.
Health Code	Char	TBD	TBD	SV health code if ≠0.
Health Code	Char	TBD	TBD	SV health code if ≠0.
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

## C.15 \$PNMRX600, Report Software Version

By sending the \$PNMRX600\*00 string to the receiver, the version of the software is output.

## C.16 \$PNMRX601, Enter ISP mode

By sending the \$PNMRX601\*00 string to the receiver, the receiver enters ISP mode.

## C.17 \$PNMRX603, Settings report

By sending the \$PNMRX603\*00 string to the receiver, the current value of the settings is output. The content of settings is split in 4 messages.

### PNMRX603 message 0

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX603	8	8	PNMRX603 protocol header.
Message Nb	Int	1	1	0
Message Sequence (7 times)	7xInt	1	1	Message Sequence
Message Delay (7 times)	7xInt	1	1	Message Delay
NMRX Message Enabled	Hex	8	8	Nemerix Message Enabled
Uart Settings	Hex	8	8	Uart settings
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

### PNMRX603 message 1

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX603	8	8	PNMRX603 protocol header.
Message Nb	Int	1	1	1
Ionospheric Data A0	Hex	2	2	Ionospheric correction $\alpha_0$ coefficient.
Ionospheric Data A1	Hex	2	2	Ionospheric correction $\alpha_1$ coefficient.
Ionospheric Data A2	Hex	2	2	Ionospheric correction $\alpha_2$ coefficient.
Ionospheric Data A3	Hex	2	2	Ionospheric correction $\alpha_3$ coefficient.
Ionospheric Data B0	Hex	2	2	Ionospheric correction $\beta_0$ coefficient.
Ionospheric Data B1	Hex	2	2	Ionospheric correction $\beta_1$ coefficient.
Ionospheric Data B2	Hex	2	2	Ionospheric correction $\beta_2$ coefficient.
Ionospheric Data B3	Hex	2	2	Ionospheric correction $\beta_3$ coefficient.
Ionospheric Data Valid	Hex	1	1	Ionospheric Data Valid. If 0 the data are invalid.
Num Blocks	Hex	1	1	Number of 20 year blocks
Time Offset (Local	Int	(-2)	(-2)	Offset of local time zone (-13) to 13

zone hours)				
Time Offset (Local zone minutes)	Int	(-)2	(-)2	
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**NMRX603 message 2**

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX603	8	8	PNMRX603 protocol header.
Message Nb	Int	1	1	2
MaxPDOP	Float			
MaxHDOP	Float			
Invalid Sv	Hex	8	8	
Min CNO	Float			
Min Elevation	Float			
Max TM	Int	2	2	
Max Sv for fix	Int	2	2	
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**PNMRX603 message 3**

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX603	8	8	PNMRX603 protocol header.
Message Nb	Int	1	1	3
Acq threshold 1	Int	3	8	
Acq threshold 2	Int	3	8	
Noise floor	Int	3	8	
Kalman Mode	Hex	1	1	
Default altitude	Int	1	8	
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**PNMRX603 message 4**

Field	Format	Min chars	Max chars	Notes
Message ID	\$PNMRX603	8	8	PNMRX603 protocol header.
Message Nb	Int	1	1	4
Correction Mode	Int	1	1	EGM96 geoids correction
Map Datum	Int	1	8	Reference number of the appropriate map datum to apply
Dx	Int	1	8	x offset in meters
Dy	Int	1	8	y offset in meters
Dz	Int	1	8	z offset in meters
Inverse flatness	Int	1	8	Inverse flatness of reference geode
Major axis	Int	1	8	Semi major axis of reference geode
Checksum	*xx	(0) 3	3	2 digits.
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

**Examples:**

\$PNMRX603\*xx: **Display the content of the Settings stored in NVRam**